International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 10, Issue 6, pp 323-334, June-2026
https://doi.org/10.47001/IRJIET/2026.106039

Health Risk Assessment of Heavy Metals in Selected Dumpsite Soil in Ondo City Metropolis, Ondo State, Nigeria

[1]*Obaseki, Olubunmi. O, [2]*Agwoko Oluwakemi. C, [3]Obire, Mathias. O

[1,2]Department of Chemistry, Federal University of Technology, Akure, Ondo State, Nigeria
[3]Department of Sociology, Dennis Osadebay University, Asaba, Nigeria. E-mail: mathias.obire@dou.edu.ng
*Corresponding Authors E-mail: [1]kemiagwoko@gmail.com, [2]orobaseki@futa.edu.ng

***Abstract* – The study investigated the health risk associated with heavy metals in dumpsites in selected locations in Ondo city, Ondo State, Nigeria. Soil samples were obtained from four selected locations namely Iyanaepe, Ileoluji road, Laje road and Barracks road. The samples were digested using the mixture of aqua regia HNO_3 and HCl(3:1) and analyzed for heavy metals using atomic absorption spectrophotometer AAS, BUCK scientific. Data analysis was done by ANOVA and t-test. The heavy metal concentration obtained in this research work were modelled for hazard index (HI) and cumulative incremental lifetime cancer risk (CILCR) via three exposure pathways (ingestion, dermal contact and inhalation). The mean hazard index was found to be 0.001715, 247.18, 1.4224, 3189.56, 9803.57, 0.5234, 0.3156 and 2.8208 for Fe, Cr, Cu, Cd, Mn, Ni, Zn and Pb (mg/kg/day) respectively. In order of magnitude Mn>Cd>Cr>Pb>Cu>Zn>Ni>fe While that of the control sites was 0.0169, 264.98, 2051.72, 0.4514 and 0.0235 for Fe, Cr, Mn, Ni and Zn (mg/kg/day) respectively. In order of magnitude Mn>Cr>Ni>Fe>Zn. Mn, Cd, Cr have hazard index remarkably greater than the threshold limit followed by Pb on the dumpsites. The mean CILCR value of Cr and Cd was beyond the threshold limit of 10^{-6}-10^{-4}. The mean CILCR value for Cr, Ni, Cd and Pb and the total hazard index (THI) on the dumpsites and control sites showed that the dumpsites pose greater health risk than the control sites.**

Keywords: Hazard index, ILCR, Heavy metals and dumpsite.

I. INTRODUCTION

Although, heavy metals occur in almost all niches of the environment, their pattern of distribution can be greatly affected by various anthropogenic activities such as mining, urbanization, agriculture, industrialization and smelting (Su, *et al.*, 2022; Tepe 2022). For Instance, an atmosphere characterized by the combustion of fossil fuel like coal, extraction of mineral resources and smelting will be with arsenic, cadmium, lead, chromium, nickel, zinc, iron, manganese e.t.c (Lak, *et al.*, polluted 2024; (Niazi, *et al.*, 2024).). Thus, the concentration and type of heavy metal found in an environment is directly proportional to the activities going on in such environment and the level of waste generated by such activities going on in the vicinity. The extensive use of heavy metals in industrial, domestic, agricultural, medical and technological innovations have highly contributed to their persistence in the environment through environmental pollution creating potential threat to the environment and human health by building up in the soil which major support for man's activities. Lead poisoning can lead to deficiencies in cognitive development in children or saturnism (Colas, 2022), anemia, neurological, respiratory, urinary and cardiovascular disorder (Mandal, *et al.*, 2022). The presence of chromium (VI) in the body can result in hemolysis which is the forerunner of kidney and liver failure (Hossini *et al.*, 2022), Gastrointestinal and skin disorder (Shin, *et al.*, 2023). Cadmium in the body system have the capability of mimicking estrogenic effects by forming high affinity complex with the hormone binding site of estrogen receptor and finally promoting the development of breast cancer especially in menopausal women (Kunioka *et al* 2022). The accumulation of cadmium has also been found to increase the risk of lung cancer and at higher concentration, it can hinder prognosis in lung cancer patients (Peana, *et al.*, 2022). Nickel and cadmium can destroy the gastric mucosa barrier leading to inflammation and tissue damage and ultimately gastric cancer (Begum, *et al.*, 2022). Other consequences of heavy metal consumption includes; arthritis, diabetes and development of several malignancies. (Bharti & Sharma 2022).

II. MATERIALS AND METHODS

Sampling site

The study was carried out in Ondo city, Nigeria during the year 2025. Ondo state has tropical climate, with an annual temperature of 26oc and average rainfall of 1122mm (44.17 inches). Ondo city has vegetation characterized by tropical

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 10, Issue 6, pp 323-334, June-2026
https://doi.org/10.47001/IRJIET/2026.106039

rainforest with lush greenery and high rainfall which enhances dense forest and agricultural activities.

Four dumpsites were selected as sampling area comprising Iyana epe dumpsite, Laje road dumpsite, Ileoluji road dumpsite and Barracks road dumpsite. These dumpsites have farm lands around them with cassava, vegetables, plantain being predominant plants around the dumpsites. The coordinates of each dumpsite was taken with the aid of hand held Global positioning system device.

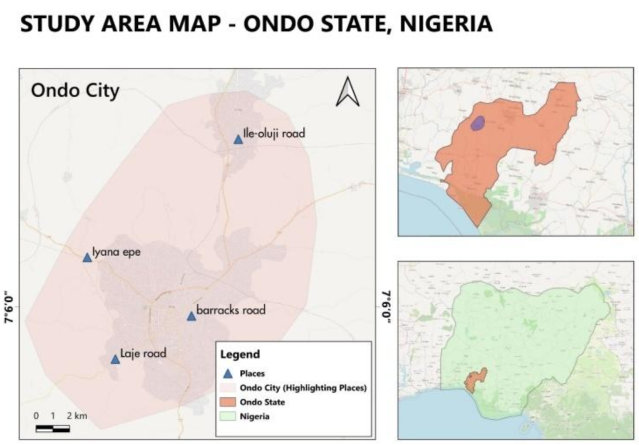

Figure 1

Sampling

Simple random sampling was used for sample collection and waste sorting was done manually on each dumpsite to separate waste into organic and inorganic.

Soil samples were collected at the depth of 0-15cm and 15-30cm at the intervals of 10m up to 30m, and control samples were also collected at a distance of 1km away from the dumpsite, taken from uncontaminated area where there was no dumpsite or any form of human activity that could generate waste to serve as control. The collection was done using stainless steel soil auger. The samples were conveyed in sterile polythene bags to the laboratory. The soil samples were air dried for seven days and then grinded with sterile porcelain mortar and pestle to obtain a composite representative sample. The samples were homogenized by coning and quartering according to the method established by Saa-Aondo, *et al* (2024). The soil samples were then stored in polythene bags and labeled accordingly before being subjected to digestion.

The materials employed for sample collection in order to ensure proper collection, labeling, transportation and preservation were selected according to USEPA (2002) sampling protocols (Abate, *et al*, 2025). All apparatus used were confirmed to be in proper working conditions according to standard laboratory protocols (Bussy, *et al.*, 2023).

III. EXPERIMENTAL PROCEDURE

Pretreatment of samples

The soil samples collected were air dried for seven days and gently ground using laboratory porcelain mortar and pestle and then passed through a 1mm sieve, stored in polythene bags and kept in a dessicator labeled for digestion.

Digestion of soil

Analysis of the elemental contents of soil samples were done using USEPA method 3050B used by Dadio, (2024). 1g of air dried soil sample was weighed and placed in 100ml Teflon beaker and 15ml of aqua regia (mixture of HNO_3 and HCl in ratio 3:1 and the mixture was heated at Low heat on hot plate in a fume cupboard for 2hours. The digest was left to cool and transferred into a 25ml conical flask and made up to the mark with distilled water and then filtered using watchman filter paper #42 into 100ml measuring cylinder and made up to the mark. The metal content (Zn, Cu, Pb, Cd, Mn, Fe, Ni, Cr) were investigated in the digested aliquots by atomic absorption spectrophotometer analysis. (model)

Human Health Risk Assessment Method

Human health risk assessment is a process to estimate the health effects that might arise from exposure to carcinogenic and non - carcinogenic metals (Samaila, 2022). The risk assessment process comprises four basic steps, Hazard identification, Exposure assessment, Dose response assessment and Risk Characterization.

The purpose of exposure is to measure or estimate the intensity, frequency and duration of human exposure to the environmental contaminants in the current study. Exposure assessment was carried out by measuring the average daily dose of heavy selected heavy metals through Ingestion and dermal contact by adults in the study area.

Dose response assessment estimates the toxicity from exposure levels of heavy metals. The cancer slope factor (CSF) which is the carcinogenic potency factor and reference dose (RFD) which is a non- carcinogenic are the two important toxicity indices used.

The risk characterization predicts potential carcinogenic and non- carcinogenic risk for adults in the study area by integrating all the collected information to obtain the quantitative estimates of cancer risk and hazard indices. The potential exposure pathways for heavy metal in contaminated vegetables are calculated based on the recommendation by several American publications. To estimate the carcinogenic risk and non- carcinogenic risk, the method developed by

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

USEPA for calculation of human health risk assessment according to (Samaila, 2022) was used.

Non carcinogenic Risk Assessment

The non-carcinogenic risk is obtained from the exposure to the contaminants through oral, ingestion and dermal contacts. It is usually expressed in terms of hazard quotient and hazard index. The hazard quotient for a single contaminant is determined by dividing the daily intake by the oral reference dose of the contaminant through ingestion and the dermal absorption.

The ingestion rate and dermal absorption rate are calculated using equation 4 and 5 respectively.

Ingestion rate (mg/kg/day)= $C_{SOIL} \times R_{ING} \times ED \times CF/BW \times AT$----------equation (4)

Dermal absorption rate (mg/kg/day) = $C_{SOIL} \times SA \times AF \times ABS \times EF/BW \times AT$ --------equation (5)

Where;

C_{SOIL} is the concentration of heavy metal in plant (mg/kg/day), R_{ING} is rate of ingestion (mg/kg/day), ED is exposure duration (year)
CF is conversion factor (unit less), BW is average body weight (kg)
AT average time (day), SA is skin surface area (cm^2)
AF is adherence factor (mg/cm^2), ABS dermal absorption factor (unit less)
EF is exposure frequency (day/year)

The non- carcinogenic risk is typically expressed in terms of hazard quotient and hazard index. The hazard quotient for a single contaminant is determined from the

The hazard quotient through oral and dermal exposure was determined using equation 6 and 7;

$HQDERMAL=ADI_{DERM}/RFD_{DERM}$---------equation (6)

$HQING=AD_{IING}/RFD_{ING}$--------equation (7)

Where

HQ_{DERMAL} is the hazard quotient of, individual metal through dermal contact
HQ_{ING} is the hazard quotient of individual metal through ingestion
HQ_{INH} is the hazard quotient of individual metal due to inhalation
ADI_{DERM} is the average daily intake through dermal contact
ADI_{ING} is the average daily intake through oral ingestion
ADI_{INH} is the average daily intake via inhalation
RFD_{ING} is the reference oral dose
RFD_{DERM} is the reference dermal dose of corresponding heavy metal and
RFD INH is the reference inhalation dose of corresponding heavy metal

Several simultaneous exposures to sub-threshold levels could result to adverse effects. Therefore summing the hazard quotient of each heavy metal having adverse or toxic effect on some organs.

Generally, hazard index of less the 0.2 is considered acceptable while a value of more than 0.2 is considered unacceptable. Similarly, Hazard index greater than unity from various paths ways is considered acceptable and the exposed population may experience adverse health effects and risk management measures should be implemented while hazard index of less than unity is considered negligible

The hazard index is calculated using the equation below;

$HI= HQ_{DERMAL}+ HQ_{ING} + HQ_{INH}$ ---------equation (8)

The total hazard index is calculated as the sum of the hazard index of all the heavy metal.

The THI was calculated according to the equation (9) below

$THI==\Sigma_i HI_i$----------equation (9)

Carcinogenic Risk Assessment

Carcinogenic risk was estimated as the incremental probability of the occurrence of cancer over a lifetime as a result of exposure to a potentially toxic metal using the equation below;

$ILCR=ADI \times CSF$ ---------------equation (10)

Where

ILCR is the incremental life cancer risk
ADI is the average daily intake and
CSF is the cancer slope factor of individual metal.

To sum the carcinogenic effect resulting from the exposure to two or more carcinogens, the cumulative incremental lifetime cancer risk was calculated from the equation below;

$CILCR= ILCR_{ING}+ILCR_{DERM}+ILCR_{INH}$---------- equation (11)

The calculations were performed by following the united states environmental protection agency's established protocols (Samaila., *et al.*, 2022).

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

Metal Values below the instrument analytical Detection limit (DL) were substituted with DL/2 in accordance with US EPA (2000) guidelines to avoid underestimation of cumulative health risks

The paremeters used in the exposure rate model above include dermal absorption factor (ABS)= 0.1, soil adherence factor (AF)= 0.07, body weight (BW)= 70, exposure duration (ED)= 30, exposure frequency (EF)= 350, ingestion rate (IR)= 100, average time (AT)= 2550, skin surface area (SA)= 3300, conversion factor (CF)= 1×10-6 (USEPA 2011).

The data generated in this study were statistically analyzed with the use of SPSS version 25.0. The means of treatment were compared statistically with analysis of variance (ANOVA) and the means separated with Duncan multiple range test (DMRT) at 5% level of significance in case of any significant differences.

IV. RESULTS AND OBSERVATION

The results of the soil samples obtained from the study sites analyzed for Fe, Cr, Mn, Zn, Cu and Ni are presented in table 2-12. The parameters used in the assessment of chronic daily intake, pollution index and incremental life cancer risks to adult consumers (ingestion, dermal contact and inhalation) were summarized in table 1.

Table 1: RFD and CSF for three exposure pathways

Parameters	Pb	Cu	Fe	Ni	Cd	Cr	Mn	Zn
RFD_{ing}	0.004	0.04	0.7	0.02	0.001	0.003	0.046	0.3
RFD_{derm}	0.000525	0.012	-	0.000525	0.000025	0.00006	0.00184	0.0015
RFD_{INH}	0.0035	0.0402	-	0.0206	2.86E-6	3.0E-5	1.46E-5	0.3
CSF_{ing}	0.042	-	-	0.840	6.3	0.41	-	-
CSF_{derm}	0.0085	-	-	-	-	42.0	-	-
CSF_{INH}	8.5E-6	-	-	-	-	0.5	-	-

Table 2: Hazard Index of Fe in Dumpsites soil samples

Location	Fe(mg/kg)	ADI ING	ADIDERM	ADIINH	HQING	HQDERM	HQINH	HI
Iyanaepe(0-15)	18025	1.0582E-2	2.444E-3	1.556	1.512E-2	-	-	1.512E-2
Ileoluji (0-15)	20775	1.2197E-2	2.8174E-3	1.794	1.7424E-2	-	-	1.7424E-2
Laje (0-15	17550	1.0303E-2	2.380E-3	1.515	1.4719E-2	-	-	1.4719E-2
Baracks road (0-15)	22200	1.3033E-2	3.0101E-3	1.917	1.8619E-2	-	-	1.8619E-2
Iyanaepe (15-30)	18775	1.1023E-2	2.546E-3	1.621	1.5747E-2	-	-	1.5747E-2
Ileoluji road (15-30)	15075	8.85E-3	2.044E-3	1.302	1.264E-3	-	-	1.264E-3
Laje road(15-30)	23775	1.3958E-2	3.224E-3	2.053	1.994E-2	-	-	1.994E-2
Barracks road(15-30)	27350	1.6057E-2	3.709E-3	2.361	2.294E-2	-	-	2.294E-2
WHO/FAO	50000					-	-	
Min	15075	8.85E-3	2.044E-3	2.3053	1.994E-2	-	-	1.994E-2
Max	27350	1.6057E-2	3.709E-3	2.361	2.294E-2	-	-	2.294E-2
Mean	20785.7	1.2203E-2	2.8186E-3	1.7947	1.7145E-2	-	-	1.7145E-2
SD	4105.96	2.411E-3	5.01E-4	0.3544	3.291E-3	-	-	3.291E-3
Acceptable limit						-	-	1

Table 3: Hazard Index and incremental life time cancer risk of Cr in Dumpsites soil samples

Location	Cr (mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI	$ILCR_{ING}$	$ILCRD_{ERM}$	$ILCR_{INH}$	CILCR
Iyanaepe (0-15)	54.5	3.1991E -5	7.391E-6	4.7053E-3	1.0664E-2	0.1232	156.83	156.96	1.3116E-5	3.104E-4	2.353E-3	2.6765E-3
Ileoluji (0-15)	65	3.816E-5	8.815E-6	5.611E-3	1.272E-2	0.1469	187	187.16	1.5646E-5	3.702E-4	2.8055E-3	3.191E-3
Laje (0-15)	113	6.6341E -5	1.532E-5	9.756E-3	2.2211E-2	0.255	325.5	325.78	2.72E-5	6.434E-4	4.878E-3	5.5486E-3

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

Baracks road (0-15)	121	7.1037E-5	1.641E-5	1.045E-2	2.3679E-2	0.2735	348.2	348.50	2.913E-5	6.89E-4	5.225E-3	5.943E-3
Iyanaepe (15-30)	22.5	1.3209E-5	3.051E-6	1.9426E-3	4.403E-3	0.0509	64.7	64.76	5.416E-6	1.281E-4	9.713E-4	1.1048E-3
Ileoluji road (15-30)	78.5	4.6086E-5	1.065E-5	6.777E-3	1.5362E-2	0.1775	225.9	226.09	1.890E-5	4.473E-4	3.3885E-3	3.8547E-3
Laje road (15-30)	103	6.047E-5	1.397E-5	8.8926E-3	2.0157E-2	0.2328	296.4	296.65	2.479E-5	5.867E-4	4.445E-3	5.0575E-2
Barracks road (15-30)	129	7.573E-5	1.749E-5	1.114E-2	2.5245E-2	0.2915	371.2	371.52	3.105E-5	7.346E-4	5.57E-3	6.3357E-2
WHO/FAO		100										
Min	22.5	1.320E-5	3.051E-6	1.9426E-3	4.403E-3	0.0509	64.7	64.76	5.416E-6	0.001281	9.713E-4	2.2257E-3
Max	129	7.573E-5	1.749E-5	1.114E-2	2.5245E-2	0.2915	371.2	371.51	3.105E-5	7.346E-3	5.57E-3	1.295E-2
Mean	85.813	5.0379E-5	1.164E-5	7.4093E-3	1.681E-2	0.1939	246.97	247.18	2.0656E-5	4.887E-4	7.7047E-3	4.2397E-3
SD	37.06	2.1965E-5	5.025E-6	3.215E-3	7.2628E-3	0.0837	106.69	106.78	8.7604E-6	2.110E-3	1.60013E-3	1.8201E-3
Acceptable limit								1				

Table 4: Hazard Index of Cu in Dumpsites soil samples

Location	Cu(mg/kg)	ADI $_{ING}$	ADI$_{DERM}$	ADI$_{INH}$	HQ$_{ING}$	HQD$_{ERM}$	HQ$_{INH}$	HI
Iyanaepe(0-15)	920.5	5.4012E-4	1.248E-4	7.947E-2	1.3503E-2	0.0104E-3	1.976	2.0
Ileoluji (0-15)	775	4.5499E-4	1.051E-4	6.691E-2	1.1374E-2	8.759E-3	1.664	1.68
Laje (0-15	166.5	9.7456E-5	2.258E-5	1.437E-2	2.4364E-3	1.882E-3	0.351	0.355
Baracks road (0-15)	633	3.872E-4	8.585E-5	5.465E-2	9.73E-3	7.153E-3	1.359	1.376
Iyanaepe (15-30)	846	4.067E-4	1.147E-4	7.304E-2	1.242E-2	9.558E-3	1.817	1.839
Ileoluji road (15-30)	1056	6.1996E-4	1.432E-4	9.117E-2	1.5499E-2	1.190E-2	2.268	2.295
Laje road(15-30)	320	1.8787E-4	4.34E-5	2.763E-2	4.6968E-3	3.616E-3	0.687	0.695
Barracks road(15-30)	524	3.076E-4	7.11E-5	4.524E-2	7.69E-3	5.922E-3	1.125	1.139
WHO/FAO	36							
Min	166.5	9.7456E-5	2.258E-5	1.437E-2	2.4364E-3	1.882E-3	0.351	0.355
Max	1056	6.1996E-4	1.432E-4	9.117E-2	1.5499E-2	1.190E-2	2.268	2.295
Mean	655.13	3.8675E-4	8.884E-5	5.656E-2	9.67E-3	6.229E-3	1.4059	1.4224
SD	304.88	1.7896E-4	4.1335E-5	2.632E-2	4.47E-3	3.840E-3	0.6562	0.664
Acceptable limit								1

Table 5: Hazard Index and incremental life time cancer risk of Cd in Dumpsites soil samples

Location	Cd(mg/kg)	ADI $_{ING}$	ADI$_{DERM}$	ADI$_{INH}$	HQ$_{ING}$	HQD$_{ERM}$	HQ$_{INH}$	HI	ILCR$_{ING}$
Iyanaepe (0-15)	365	2.143E-4	4.95E-5	3.152E-2	2.143E-1	1.98E-5	11020.98	11023.4	1.35E-3
Ileoluji (0-15)	75	4.4031E-5	1.017E-5	6.475E-3	4.4013E-2	0.4068	2263.99	2264.4	2.774E-4
Laje (0-15	15	8.806E-6	2.034E-6	1.295E-3	8.8806E-3	8.137E-2	452.8	452.9	5.548E-5
Baracks road (0-15)	0.005	2.94E-9	6.7808E-10	4.318E-19	2.94E-6	2.7123E-5	1.5098E-14	3.0063E-5	1.852E-8
Iyanaepe (15-30)	350	2.055E-4	4.747E-5	3.022E-2	0.2055	1.899	10566	10568.11	1.295E-3
Ileoluji road	30	1.7613E-5	4.0685E-6	2.590E-3	1.7613E-2	0.1627	905.59	905.77	1.110E-4

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

(15-30)									
Laje road (15-30)	10	5.870E-6	1.3562E-6	8.6336E-4	5.87E-3	5.2425E-2	301.87	301.93	3.700E-5
Barracks road (15-30)	0.005	2.94E-9	6.7808E-10	4.318E-19	2.94E-6	2.7123E-5	1.5098E-14	3.0063E-5	1.852E-8
WHO/FAO	0.8							1	10^{-6}-10^{-4}
Min	0.005	2.94E-9	0	4.318E-19	2.94E-6	2.7123E-5	1.5098E-14	3.0063E-5	1.852E-8
Max	365	2.143E-4	4.95E-5	3.152E-2	2.143E-1	1.98E-5	11020.98	11023.4	1.35E-3
Mean	105.62	6.202E-5	1.433E-5	9.120E-3	6.202E-2	0.5730	3188.96	3189.56	3.9074E-4
SD	157.3	9.238E-5	2.134E-5	1.3588E-2	9.238E-2	0.8537	4874.32	4751.81	5.8209E-4
Acceptable limit									

Table 6: Hazard Index of Mn in Dumpsites soil samples

Location	Mn(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI
Iyanaepe (0-15)	1890	1.1096E-3	2.563E-4	0.16317	2.4121E-2	0.1393	11410.77	11410.93
Ileoluji (0-15)	1752	1.0286E-3	2.376E-4	0.1513	2.2361E-2	0.1291	10557.6	10557.75
Laje (0-15)	1582	9.2877E-4	2.145E-4	0.13658	2.0191E-2	0.1166	9551.3	9551.44
Baracks road (0-15)	1202	7.0568E-4	1.630E-4	0.10377	1.5341E-2	0.0886	7257	7258.0
Iyanaepe (15-30)	1925.5	1.1304E-3	2.611E-4	0.1662	2.4574E-2	0.1419	11625	11625.17
Ileoluji road (15-30)	1875	1.1008E-3	2.543E-4	0.1619	2.393E-2	0.1382	11320.2	11320.36
Laje road (15-30)	1897	1.1137E-3	2.573E-4	0.1638	2.421E-2	0.1398	11453	11453.16
Barracks road (15-30)	958	5.6243E-4	1.399E-4	0.08271	1.2227E-2	0.0706	5783.9	5783.98
WHO/FAO	2000							
Min	958	5.6243E-4	1.399E-4	0.08271	1.2227E-2	0.0706	5783.9	5783.98
Max	1925.5	1.1304E-3	2.611E-4	0.1662	2.4574E-2	0.1419	11625	11625.17
Mean	1635.19	9.60E-4	2.2175E-4	0.1414	0.02087	0.1205	9803.43	9803.57
SD	366.06	2.149E-4	2.4595E-4	0.03172	0.00467	0.02699	3891.36	3891.39
Acceptable limit								1

Table 7: Hazard Index and incremental life time cancer risk of Ni in Dumpsites soil samples

Location	Ni(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI	ILCR
Iyanaepe (0-15)	49.5	2.9061E-5	6.713E-6	4.273E-3	1.453E-3	0.0127	0.2075	0.2217	2.441E-5
Ileoluji (0-15)	69.5	4.0802E-5	9.425E-6	6.000E-3	2.0401E-3	0.01795	0.2913	0.31129	3.427E-5
Laje (0-15)	126.5	7.4266E-5	1.716E-5	1.0921E-3	3.7133E-3	0.0327	0.5301	0.5665	6.238E-5
Baracks road (0-15)	189	1.1096E-4	2.563E-5	1.632E-2	5.548E-3	0.488	0.7921	0.8464	9.321E-5
Iyanaepe (15-30)	35	2.0548E-5	4.747E-6	3.0218E-3	1.0274E-3	0.009041	0.1467	0.1568	1.726E-5
Ileoluji road (15-30)	156	9.1585E-5	2.116E-5	1.347E-2	4.5793E-3	0.0403	0.6538	0.6997	7.693E-5
Laje road (15-30)	100.5	5.9002E-5	1.363E-5	8.6761E-3	2.9501E-3	0.02596	0.4212	0.4501	4.953E-5
Barracks road (15-30)	209	1.227E-4	2.834E-5	1.8044E-2	6.135E-3	0.05399	0.8759	0.9360	1.031E-4
WHO/FAO	35								
Min	35	2.0548E-5	4.747E-6	3.0218E-3	1.0274E-3	0.009041	0.1467	0.1568	1.726E-5
Max	209	1.227E-4	2.834E-5	1.8044E-2	6.135E-3	0.05399	0.8759	0.9360	1.031E-4
Mean	116.875	6.8616E-5	1.5851E-5	8.8621E-3	3.4302E-6	0.03019	0.4898	0.5234	5.7254E-5
SD	63.256	3.7832E-5	8.7385E-6	6.38E-3	1.825E-3	0.0166	0.27005	0.2885	3.1821E-5
Acceptable limit								1	10^{-6}-10^{-4}

Table 8: Hazard Index of Zn in Dumpsites soil samples

Location	Zn(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQ_{DERM}	HQ_{INH}	HI
Iyanaepe(0-15)	1037	6.0881E-4	1.406E-4	8.953E-2	2.0294E-3	1.875E-2	0.2984	0.3192
Ileoluji (0-15)	1045	6.135E-4	1.417E-4	9.0221E-2	2.045E-3	1.89E-2	0.3007	0.3216
Laje (0-15	992	5.8239E-4	1.345E-4	8.565E-2	1.9413E-3	1.79E-2	0.2855	0.3053

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

Baracks road (0-15)	999	5.865E-4	1.355E-4	8.625E-2	1.955E-3	1.807E-2	0.2875	0.3075
Iyanaepe (15-30)	1032	6.0587E-4	1.400E-4	8.9099E-2	2.0196E-3	1.867E-2	0.2969	0.3176
Ileoluji road (15-30)	1068	6.2701E-4	1.448E-4	9.2207E-2	2.0900E-3	1.931E-2	0.3074	0.3288
Laje road(15-30)	1072	6.2940E-4	1.454E-4	9.255E-2	2.098E-3	1.937E-2	0.3085	0.3300
Barracks road(15-30)	958.5	5.6272E-4	1.300E-4	8.2753E-2	1.8757E-3	1.733E-2	0.2758	0.2950
WHO/FAO	50							
Min	958.5	5.6272E-4	1.300E-4	8.2753E-2	1.8757E-3	1.733E-2	0.2758	0.2950
Max	1072	6.2940E-4	1.454E-4	9.255E-2	2.098E-3	1.937E-2	0.3085	0.3300
Mean	1025.4	6.0203E-4	1.3906E-4	8.8531E-2	2.0068E-3	1.854E-2	0.2951	0.3156
SD	39.35	2.3107E-5	5.3308E-6	3.3952E-3	7.7029E-5	7.138E-4	0.0113	0.0121
Acceptable limit								1

Table 9: Hazard Index and incremental life time cancer risk of Pb in Dumpsites soil samples

Location	Pb (mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQ_{DERM}	HQ_{INH}	HI	$ILCR_{ING}$	$ILCR_{DERM}$	$ILCR_{INH}$	CI_{LCR}
Iyanaepe (0-15)	145	8.5127E-5	1.996E-5	1.2518E-2	2.1282E-2	3.746E-2	3.576	3.6347	3.57E-6	1.697E-7	1.064E-7	3.8511E-6
Ileoluji (0-15)	84	4.9315E-5	1.139E-5	7.252E-3	1.2329E-2	2.169E-2	2.072	2.1060	2.071E-6	9.682E-8	6.164E-8	2.2295E-6
Laje (0-15)	0.04	2.348E-8	5.42E-9	3.4534E-18	5.87E-6	1.0324E-5	9.8669E-16	1.6194E-5	9.8616E-10	4.607E-11	2.9354E-23	1.03E-9
Baracks road (0-15)	30	1.7612E-5	4.060E-6	2.59E-3	4.403E-3	7.7400E-3	0.7400	0.7521	7.397E-7	3.459E-8	2.202E-7	9.9449E-7
Iyanaepe (15-30)	178	1.045E-4	2.414E-5	1.5367E-2	2.6125E-2	4.598E-2	4.390	4.462	4.389E-6	2.0519E-7	3.522E-8	4.7228E-6
Ileoluji road (15-30)	48	2.818E-5	6.5100E-6	4.144E-3	7.045E-3	1.2400E-2	1.184	1.2034	1.184E-5	5.534E-8	3.126E-7	1.2746E-6
Laje road (15-30)	426	2.5098E-4	5.777E-5	3.678E-2	6.2745E-2	1.1038E-1	10.508	10.68	1.054E-5	4.910E-7	2.9354E-23	1.1344E-5
Barracks road (15-30)	0.04	2.348E-8	5.4200E-9	3.4534E-18	5.8700E-6	1.0324E-5	9.8669E-16	1.6194E-5	9.8616E-10	4.607E-11		1.03E-9
WHO/FAO	100											
Min	0.04	2.348E-8	5.4200E-9	3.4534E-18	5.8700E-6	1.0324E-5	9.8669E-16	1.6194E-5	9.8616E-10	4.607E-11	2.9354E-23	1.03E-9
Max	426	2.5098E-4	5.777E-5	3.678E-2	6.2745E-2	1.1038E-1	10.508	10.68	1.054E-5	4.910E-7	2.9354E-23	1.1344E-5
Mean	113.89	6.6970E-5	1.4581E-5	9.8314E-3	1.674E-2	2.941E-2	2.8088E-2	2.8208	2.8126E-6	1.3159E-7	1.0837E-7	3.0523E-6
SD	141.036	4.606E-8	1.8908E-5	1.2241E-2	2.0877E-2	3.667E-2	3.5654E-2	3.5471	3.5069E-6	1.6348E-7	1.1063E-7	3.7583E-6
Acceptable limit								1				10-6-10-4

Table 10: Hazard Index of Fe in control soil samples

Location	Fe(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI
Iyanaepe(0-15)	18925	1.1111e-2	2.5665E-3	1.6339	1.5872E-2	-	-	1.5872E-2
Ileoluji (0-15)	28958	1.70008e-2	3.926E-3	2.499	2.4287E-2	-	-	2.4287E-2
Laje (0-15	23875	1.4017E-2	3.237E-3	2.061	2.0024E-2	-	-	2.0024E-2
Baracks road (0-15)	26500	1.5577E-2	3.594E-3	2.288	2.2225E-2	-	-	2.2225E-2
Iyanaepe (15-30)	21500	1.2622E-2	2.915E-3	1.856	1.8031E-2	-	-	1.8031E-2
Ileoluji road (15-30)	8175	4.799E-3	1.109E-3	0.7058	6.8557E-3	-	-	6.8557E-3
Laje road(15-30)	17850	1.0479E-2	2.421E-3	1.541	1.497E-2	-	-	1.497E-2
Barracks road(15-30)	14750	8.659E-3	2.000E-3	1.273	1.237E-2	-	-	1.237E-2

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

WHO/FAO	50000					-	-	
Min	8175	4.799E-3	1.109E-3	0.7058	6.8557E-3	-	-	6.8557E-3
Max	28958	1.70008e-2	3.926E-3	2.499	2.4287E-2	-	-	2.4287E-2
Mean	20066.3	1.2533E-2	2.721E-3	1.7322	1.690E-2	-	-	1.690E-2
SD	6685.78	3.9315E-3	8.912E-4	0.5771	5.700E-3	-	-	5.700E-3
Acceptable limit					0.2	-	-	1

Table 11: Hazard Index of Cr control sites soil samples

Location	Cr(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI	$ILCR_{ING}$	$ILCRD_{ERM}$	$ILCR_{INH}$	CILCR
Iyanaepe (0-15)	27	1.5851E-5	3.661E-6	2.311E-3	5.284E-3	0.06102	77.7	77.77	6.499E-6	1.538E-4	1.156E-3	1.3165E-3
Ileoluji (0-15)	76	4.4618E-5	1.031E-5	6.562E-3	1.4873E-2	0.1718	218.7	218.89	1.829E-5	4.33E-4	3.281E-3	3.732E-3
Laje (0-15)	108	6.3405E-5	1.465E-5	9.324E-3	2.1135E-2	0.2441	310.8	311.07	2.600E-5	6.115E-4	4.662E-3	6.300E-3
Baracks road (0-15)	135	7.9256E-5	1.831E=-5	1.1699E-2	2.6419E-2	0.3051	389.97	390.30	3.249E-5	7.690E-4	5.850E-3	6.6515E-3
Iyanaepe (15-30)	47	2.7592E-5	6.374E-6	4.057E-3	9.1973E-3	0.1062	135.23	135.35	1.13E-5	2.677E-4	2.029E-3	2.308E-3
Ileoluji road (15-30)	100.5	5.9002E-5	1.363E-5	8.6768E-3	1.9667E-2	0.2270	289.23	289.48	2.419E-5	5.725E-4	4.338E-3	4.9347E-3
Laje road (15-30)	124	7.2798E-5	1.682E-5	1.0706E-2	2.4266E-2	0.2030	356.84	357.07	2.985E-5	7.06E-4	5.353E-3	6.0889E-3
Barracks road (15-30)	118	6.9276E-5	1.6003E-5	1.0188E-2	2.3092E-2	0.2667	339.59	339.88	2.840E-5	6.72E-4	5.094E-3	5.7944E-3
WHO/FAO	100											
Min	27	1.5851E-5	3.661E-6	2.311E-3	5.284E-3	0.06102	77.7	77.77	6.499E-6	5.212E-4	1.156E-3	4.51564E-3
Max	135	7.9256E-5	1.831E=-5	1.1699E-2	2.6419E-2	0.3051	389.97	390.30	3.249E-5	2.1481E-4	15.850E-3	1.9232E-4
Mean	91.938	5.397E-5	1.247E-5	0.018	1.800E-2	0.1981	264.76	264.98	2.2127E-5	5.232E-3	3.9704E-3	9.2289E-3
SD	38.51	2.261E-5	5.224E-6	0.0075	7.500E-3	0.0820	111.08	111.16	8.9979E-6	2.1976E-3	1.6593E-3	9.2245E-3
Acceptable limit					0.2	0.2	0.2	1				10^{-6}-10^{-4}

Table 12: Hazard Index of Mn in control sites soil samples

Location	Mn(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI
Iyanaepe(0-15)	270.5	1.588e-4	3.668e-5	2.335e-2	3.452e-3	1.993E-2	1632.87	1632.89
Ileoluji (0-15)	372	2.184e-4	5.0449e-5	3.212e-2	4.7478e-3	2.742e-2	2245.9	2246.18
Laje (0-15	360	2.114e-4	4.8820e-5	3.108e-2	4.5957e-3	2.6532E-2	2173.5	2173.77
Baracks road (0-15)	483	2.836e-4	6.550e-5	4.170e-2	6.165e-3	3.5600E-2	2916.1	2916.14
Iyanaepe (15-30)	248	1.456e-4	3.336e-5	2.1411e-2	3.1652e-3	1.813E-2	1497.3	1497.32
Ileoluji road (15-30)	301.5	1.770e-4	4.0890e-5	2.603e-2	3.8478e-3	2.2220E-2	1820.3	1820.33
Laje road(15-30)	378.5	2.222e-4	5.133e-5	3.268e-2	4.8304e-3	2.7900E-2	2285.2	2285.23
Barracks road(15-30)	304.5	1.788e-4	4.130e-5	2.629e-2	3.887e-3	2.2400E-2	1838.4	1838.43
WHO/FAO	2000							
Min	248	1.456e-4	3.336e-5	2.1411e-2	3.1652e-3	1.813E-2	1497.3	1497.32
Max	483	2.836e-4	6.550e-5	4.170e-2	6.165e-3	3.5600E-2	2916.1	2916.14
Mean	339.69	1.995e-4	4.604e-5	2.933e-2	4.336e-3	2.5010E-2	2051.2	2051.72
SD	75.08	4.405e-5	1.022e-5	6.480e-3	9.576e-4	5.5610E-3	452.94	452.95
Acceptable limit					0.2	0.2	0.2	1

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

Table 13: Hazard Index and incremental life time cancer risk of Ni in control sites soil samples

Location	Ni(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI	$ILCR_{ING}$
Iyanaepe (0-15)	26	1.5260E-5	3.526E-6	2.2447E-3	7.630E-4	6.716E-3	0.10896	0.1164	1.282E-5
Ileoluji (0-15)	56	3.2880E-5	7.594E-6	4.8348E-3	1.644E-3	1.447E-2	0.2347	0.2508	2.762E-5
Laje (0-15)	135	7.9260E-5	1.831E-5	1.1655E-2	3.963E-3	3.487E-2	0.5658	0.6046	6.658E-5
Baracks road (0-15)	199	1.1680E-4	2.699E-5	1.7181E-2	5.84E-3	5.141E-2	0.83402	0.89127	9.811E-5
Iyanaepe (15-30)	28	1.6440E-5	3.7978E-6	2.411E-3	8.220E-4	7.232E-3	0.11704	0.1251	1.381E-5
Ileoluji road (15-30)	76	4.4618E-5	1.031E-5	6.5615E-3	2.230E-3	1.963E-2	0.3185	0.3404	3.748E-5
Laje road (15-30)	148	8.6890E-5	2.007E-5	1.277E-2	4.3445E-3	3.823E-2	0.6202	0.6628	7.299E-5
Barracks road (15-30)	138.5	8.1310E-5	1.878E-5	1.1957E-2	4.0655E-3	3.577E-2	0.5804	0.6202	6.830E-5
WHO/FAO	35								
Min	26	1.5260E-5	3.526E-6	2.2447E-3	7.630E-4	6.716E-3	0.10896	0.1164	1.282E-5
Max	199	1.1680E-4	2.699E-5	1.7181E-2	5.84E-3	5.141E-2	0.83402	0.89127	9.811E-5
Mean	100.5	5.918E-5	1.3672E-5	8.7019E-3	2.9591E-3	2.6041E-2	0.4225	0.4514	4.9714E-5
SD	63.22	3.711E-5	8.5741E-6	5.4585E-3	1.8555E-3	1.6331E-2	0.2650	0.2832	3.1515E-5
Acceptable limit					0.2	0.2	0.2	1	10^{-6}-10^{-4}

Table 14: Hazard Index of Zn in control sites soil samples

Location	Zn(mg/kg)	ADI_{ING}	ADI_{DERM}	ADI_{INH}	HQ_{ING}	HQD_{ERM}	HQ_{INH}	HI
Iyanaepe (0-15)	65.5	3.845E-5	8.883E-6	5.6550E-3	1.2817E-4	1.184E-3	1.885E-2	2.0162E-2
Ileoluji (0-15)	64	3.757E-5	8.679E-6	5.5255E-3	1.2523E-4	1.1157E-3	1.842E-2	1.97E-2
Laje (0-15)	79	4.638E-5	1.071E-5	6.8205E-3	1.546E-4	1.428E-3	2.274E-2	2.4323E-2
Baracks road (0-15)	120	7.045E-5	1.627E-5	1.036E-2	2.3483E-4	2.169E-3	3.45E-2	3.6903E-2
Iyanaepe (15-30)	76	4.462E-5	1.031E-5	6.5615E-3	1.4873E-4	1.374E-3	2.187E-2	2.339E-2
Ileoluji road (15-30)	87	5.108E-5	1.1799E-5	7.5712E-3	1.7027E-4	1.573E-3	2.504E-2	2.678E-2
Laje road (15-30)	65	3.816E-5	8.8151E-6	5.6118E-3	1.272E-4	1.175E-3	1.871E-2	2.0012E-2
Barracks road (15-30)	60	3.523E-5	8.137E-6	5.180E-3	1.1743E-4	1.085E-3	1.727E-2	1.847E-2
WHO/FAO	50							
Min	60	3.523E-5	8.137E-6	5.180E-3	1.1743E-4	1.085E-3	1.727E-2	1.847E-2
Max	120	7.045E-5	1.627E-5	1.036E-2	2.3483E-4	2.169E-3	3.45E-2	3.6903E-2
Mean	77.06	4.524E-5	1.045E-5	6.661E-3	1.6301E-4	1.3931E-3	2.2175E-2	2.351E-2
SD	19.618	1.151E-5	2.656E-6	1.696E-3	4.3123E-5	3.3598E-4	5.615E-3	6.094E-3
Acceptable limit					0.2	0.2	0.2	1

Table 15: Total Hazard Index (THI) of Heavy Metals in Dumpsites and Control Sites

Location/Sample	DUMPSITE	CONTROL SITE
Iyanaepe	22597.08	1714.26
Ile-oluji road	13013.583	2465.36
Laje road	10331.56	2485.49
Barracks road	7609.8	3307.39
Iyanaepe	22264.83	1632.84
Ile-oluji road	12456.75	2110.16
Laje road	12063.92	2643.18
Barracks road	6459.82	2178.96
Min	6459.82	1714.26
Max	22597.08	3307.39
Mean	13349.67	2317.21
SD	6060.21	538.632
Acceptable limit	1	1

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

V. RESULTS AND DISCUSSION

The hazard index for all the exposure pathways (ingestion, dermal contact and inhalation) was found to be 0.01714, 247.18, 1.4224, 3189.5, 9803.51, 0.5234, 0.3156 and 2.8208 for Fe, Cr, Cu, Cd, Mn, Ni, Zn and Pb (mg/kg/day) respectively in the order of magnitude Mn>Cd>Cr>Pb>Cu>Ni>Zn>Fe. Mn, Cd and Cr have the highest hazard index in dumpsites soil samples. The hazard index for heavy metals in the control site was 0.0169, 264.98, 2051.72, 0.45144 and 0.0257 for Fe, Cr, Mn, Ni and Zn (mg/kg/day) respectively in the order of magnitude Mn> Cr> Ni> Zn>Fe. Mn and Cr have the highest have the highest hazard index in the control sites soil samples analyzed. The concentration of Cd and Pb was below detectable limit in 25% of the total samples analyzed for heavy metals in all locations. Therefore based on the standard of US EPA (2011/2002, half the instrument's limit of detection for each metals was used for the determination of the health risk posed by the heavy metals under study. Cu concentration was also below detectable limit in 75% of the samples analyzed for heavy metals, therefore, Cu hazard index was excluded in the determination of health risk of heavy metals based on USEPA (2025). The mean total hazard index (THI) for heavy metals presented in table 14 was 13349.67 and 2317.21 for the dumpsites and control sites respectively. The result of the mean of THI revealed that exposure to heavy metals via dumpsites soil poses higher health risk than that of the control sites.

USEPA considered an overall hazard index of 1.0 as an acceptable threshold, below which no observable clinical effect was reported in experimental animals (Samaila 2023). The hazard index of heavy metals reported in this research was less than the threshold limit for non- carcinogenic risks.

In table 2, the hazard index of Fe in dumpsite was found to be in the order of magnitude Barracks road>Laje road >Iyanaepe>Ile-oluji road while table 10 also found to also reveal the same pattern. Although the hazard index of heavy metal for Fe was higher in the control sites than the dumpsites the hazard index of heavy metals for Fe was below the threshold limit in all samples. This indicates that dwellers of these locations are unlikely to experience non carcinogenic risk due to exposure to heavy metals.

Comparing to table 3 and 11, the hazard of heavy metals for Cr in both dumpsites and control was found to be in the order of magnitude Barracks road>Laje road> Ile-oluji road>Iyanaepe. The hazard index of heavy metals for Cr in the control sites was higher than that of the dumpsites except in Iyana epe. This indicates that that the control site poses a higher health risk than the dumpsites. All the hazard index of heavy metals for Cr were remarkably higher than the threshold limit indicating that dwellers of this locations are at the risk of experiencing non carcinogenic risk due to exposure to heavy metals. The mean cumulative incremental lifetime values for Cr in dumpsites and control sites exceeded USEPA threshold limit of 10^{-6}-10^{-4}. This indicates that dwellers of these locations are likely to develop cancer and other related diseases in the future.

According to table 4, the hazard index of heavy metals for Cu due to exposure to dumpsite soil was in the order of magnitude Ile-oluji road>Iyanaepe>Barracks road>Laje road. The hazard index of Cu in all the dumpsite locations was beyond the threshold limit except in Laje road. The health risk due to exposure to Cu was not determined in the control sites because 75% of Cu concentration was below detectable limit. This result indicates that the dumpsites pose more health risk than the control site due to exposure to Cu via soil. Table 5 revealed the hazard index of heavy metals for Cd was found to be in the order of magnitude Iyanaepe>Ile-oluji road>Laje road>Barracks road. The hazard index of Cd in all the dumpsite soil samples was beyond the acceptable limit. This indicates that dwellers of these locations are prone to non-carcinogenic risks due to exposure to Cd via contact with dumpsites soil. Cd was not detected in soil samples from all the control sites soil samples. This indicates that exposure to dumpsites soil poses more health risk than that of the control site soil. Table 5 further revealed that the CILCR of Cd in all the individual dumpsites was higher the threshold limit except in Barracks road. Also, the mean CILCR of Cd due to exposure to dumpsite soil s was found to be beyond the threshold limit of 10^{-6}-10^{-4}, signifying that dwellers of these locations are at the risk of developing cancer and other related disease in the future. Since Cd concentration in the control site was below detectable limit, exposure to control sites soil may not pose any health risk to the dwellers.

Table 6 recorded the hazard index of heavy metals for Mn in the dumpsites in the order of magnitude Iyana epe>Ile-oluji road>Laje road>Barracks road. This implies that Iyana-epe poses more health risk than other dumpsites. While that of the control sites recorded in table 12 is in the order of magnitude Barracks road >Laje road >Ile-oluji road >Iyana epe. The mean hazard index for Mn in all the dumpsites was higher than that of the control sites. This signifies that dwellers are susceptible to non- carcinogenic risk than dwellers of the control sites. The hazard index recorded for Mn in both dumpsites and control sites was remarkably higher than the threshold limit. This indicates that receptors are prone to health risk.

Table 7 revealed the Hazard index of Ni in dumpsites while that of the control sites recorded in table 13 showed that

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 10, Issue 6, pp 323-334, June-2026
https://doi.org/10.47001/IRJIET/2026.106039

the HI was found to be in the order of magnitude Barracks road>Laje road> Ile-oluji road>Iyanaepe. Barracks road had the highest index. However, the hazard index in all the locations was less than the threshold limit. Moreover, the mean CILCR for NI recorded in table 7 was within the threshold limit of 10^{-6}-10^{-4}. This result indicates that receptors are unlikely to develop cancer or any related disease in the future.

Table 8 recorded the hazard index of heavy metals for Zn in dumpsites in the order of magnitude Ile-oluji road>Iyanaepe>Laje road>Barracks road. Ileoluji road poses more health risk than other dumpsites while that of the control site recorded in table 14 is in the order of magnitude Barracks road> Ile-oluji road>Laje road>Iyanaepe. This implies that Barracks road poses more health in the control sites. The hazard index of heavy metals for Zn was less than the threshold limit. This implies that dwellers of these locations are unlikely to experience any non-carcinogenic risk.

Table 9 recorded the hazard index of Pb in dumpsites soil in the order of magnitude Barracks road>Iyanaepe>Ile-oluji road>Laje road. All the hazard index of heavy metals for Pb was in beyond the acceptable limit. This signifies that dwellers of these locations are likely to experience non carcinogenic risk due to exposure to Pb via soil. The table further recorded mean CILCR was within the range of 10^{-6}-10^{-4}, dwellers of these locations are unlikely to develop cancer in the future.

The result of the total hazard index (THI) for heavy metals in the dumpsites and control sites was recorded in table 14 in the order of magnitude Iyanaepe>Ile-oluji road>Laje road>Barracks road and Barracks road>Laje road> Ile-oluji road>Iyanaepe respectively. The mean THI value revealed that that the hazard index of heavy metals on the dumpsites was higher than that of the control sites. This implies that exposure to dumpsite soil poses more health risk than the control sites. All the THI values for dumpsites and control sites were greater than the threshold limit of 1. This implies that people living in these locations are prone to experience non carcinogenic risk.

VI. CONCLUSION

In this work, heavy metals concentration from dumpsites and control sites was investigated to assess the hazard index and cancer risk to inhabitants of the locations. The results of this research revealed that Cr and Cd have the highest incremental lifetime cancer risk in all locations. Hence the adults are at more risk for which ingestion is the main contributor to excess lifetime cancer risk followed by dermal pathways. This study provides a good basis for further research on the impact of dumpsites soils on human health and the environment. The work could serve as a base line heavy metal risk associated with the studied area to monitor improvements or further degradation with time. Considering the health hazard posed by the accumulation of these heavy metals on human health, the studied areas need to require proper monitoring. There is need for educationist, environmentalist and other interested stake holders to develop strategies to combat the problems created by heavy metals through ingestion, Inhalation and dermal contact with the body.

Recommendation

There is need for health scientist to carry out further study on the health impacts of heavy metals on vulnerable populations such as children and pregnant women.

REFERENCES

[1] Abate, G. G. (2025). Soil sampling and sample preparation. *International Journal of Modern Science and Research Technology*.

[2] Dadio, S. (2024). An Investigation of Elemental Soil Composition Testing Methods and Site Assessment Procedure For Determining Trace Elemental Pollutant Concentrations In Urban Soils.

[3] Saa-Aondo, M., Asose, A., Kalu, K. M., Yelwa, J. M., Abdullahi, S., Chinedu, E. K and Ndahi, J. A. (2024). Efficiencies of Heavy Metal Hyper-accumulation Plants as Potential Land Remediators for Heavy Metal Polluted Soils. *Asian J. Curr. Res,* 9(1), 60-70.

[4] Samaila, B. (2022). Human Health Risk Assessment of Heavy Metals in Tailings of Gold ore Matrix Using Proton Induced X-ray Emission Technique. *Int. J. Sci. Res. in Multidisciplinary Studies* Vol, 8(7).

[5] Su, C., Meng, J., Zhou, Y., Bi, R., Chen, Z., Diao, J. and Wang, T. (2022). Heavy metals in soils from intense industrial areas in south China: Spatial distribution, source apportionment, and risk assessment. *Frontiers in Environmental Science*, 10, 820536.

[6] Tepe, Y., Şimşek, A., Ustaoğlu, F andTaş, B. (2022). Spatial–temporal distribution and pollution indices of heavy metals in the Turnasuyu Stream sediment, Turkey. *Environmental monitoring and assessment*, 194(11), 818.

[7] USEPA. (2000). Guidance for Data Quality Assessment: Practical Methods for Data Analysis. EPA QA/G-9, QA00 Update. *United States Environmental Protection Agency*.

[8] USEPA. (2011). Exposure Factors Handbook 2011 Edition (Final Report). U.S. *Environmental Protection Agency, Washington*, DC, EPA/600/R-09/052F.

ISSN (online): 2581-3048

Volume 10, Issue 6, pp 323-334, June-2026

https://doi.org/10.47001/IRJIET/2026.106039

[9] Mandal, G. C., Mandal, A., and Chakraborty, A. (2022). The toxic effect of lead on human health: A review. *Human biology and public health*, 3.

[10] Kunioka, C. T., Manso, M. C and Carvalho, M. (2022). Association between environmental cadmium exposure and osteoporosis risk in postmenopausal women: a systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 20(1), 485.

[11] Peana, M., Pelucelli, A., Medici, S., Cappai, R., Nurchi, V. M and Zoroddu, M. A. (2021). Metal toxicity and speciation: a review. *Current Medicinal Chemistry*, 28(35), 7190-7208.

[12] Bharti, R., & Sharma, R. (2022). Effect of heavy metals: An overview. *Materials Today: Proceedings*, 51, 880-885.

Citation of this Article:

Obaseki, Olubunmi. O, Agwoko Oluwakemi. C, & Obire, Mathias. O. (2026). Health Risk Assessment of Heavy Metals in Selected Dumpsite Soil in Ondo City Metropolis, Ondo State, Nigeria. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 10(6), 323-334. Article DOI https://doi.org/10.47001/IRJIET/2026.106039

****